

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:

<https://www.esrf.fr/misapps/SMISWebClient/protected/welcome.do>

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.



	Experiment title: Elucidating the toxicity mechanism of biogenic nano selenium in aquatic model organisms	Experiment number: 26-01-963
Beamline: BM26A	Date of experiment: from: 21 June 2013 to: 25 June 2013	Date of report: 08.7.13
Shifts: 12	Local contact(s): BANERJEE Dipanjan (NIKITENKO Sergey)	<i>Received at ESRF:</i>

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Report:

A) Overview

In the environment, microorganisms control Se fate by reducing toxic-, water soluble oxyanions (selenite, selenate) to elemental Se. This has been applied in the past in the frame of bioremediation to decontaminate wastewaters. Microbial products formed are of nanometer size (biogenic elemental nano selenium, BioNSe)^{1,2}, which raises concern due to the considerably different physiological activity (i.e. nanotoxicity) of nanomaterials. When such BioNSe particles are released from bioremediation systems and enter the aqueous environment of receiving waters, they may be taken up and biotransformed by organisms, for instance *Daphnia*. BioNSe consists of a thermodynamically meta-stable allotrope, which can be transformed to trigonal Se. Using *Daphnia magna*, a model organism for ecotoxicity, we could recently demonstrate the latter allotropes differ substantially in their toxicity. At the DUBBLE beamline at ESRF, we could now for the first time successfully quantify the latter phase transformations during different exposure conditions prevailing in the toxicity experiments. Furthermore, the measurements at DUBBLE allowed us to firstly assess Se speciation within Daphnids that had been exposed to different Se forms (BioNSe and further Se nanoparticles, as well as dissolved Se).

B) Quality of measurement/data

The runs have been successful and data recorded is of very high quality. A variety of Se K-edge spectra were collected at DUBBLE for previously not studied model compounds relevant for Se speciation in Daphnids (Figure 1B). Se speciation within the Daphnids could be recorded even in samples were fairly diluted in

selenium (i.e. environmentally relevant exposure concentrations of $\sim 200 \mu\text{g} / \text{L}$) (Figure 1A). We want to take the opportunity to state that the support by Dr. Dipanjan Banerjee was excellent in every aspect.

C) Status and progress of evaluation

Data reduction and analysis is underway, using a variety of methods. However, it is too early to provide any definitive result at this time, because XAFS requires very careful analysis. Still, the significantly different XANES and EXAFS features recorded may allow already for some first careful conclusions (see D).

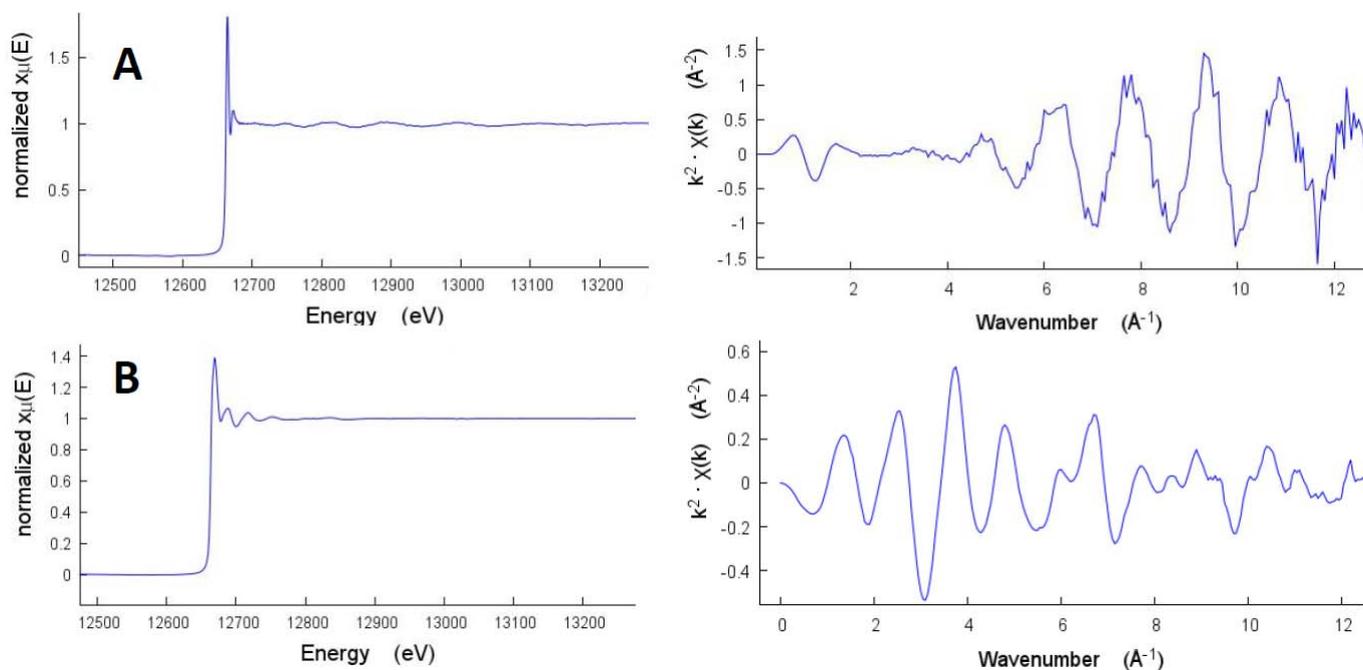


Figure 1. Selenium K-edge spectra collected at DUBBLE of *Daphnia magna* tissue speciation diluted in selenium (A) with k^2 -weighted EXAFS and of previously non-studied organic Se species relevant for nanotoxicity (B) with k^2 -weighted EXAFS spectra.

D) Results

Although in depth analysis is still in progress, we can already conclude that Se phase transformations from BioNSe towards trigonal Se indeed can take place in aqueous environments, crucially determining Se toxicity. In addition, substantially different XAFS features (XANES, EXAFS) indicate that Se speciation within Daphnids is strongly dependent on the form of Se fed. The results gained at DUBBLE will thus provide a more detailed understanding of mechanisms that underlie the severe toxicity of BioNSe towards model organisms.

References:

1. Buchs, B., Evangelou, M. W. H., Winkel, L. H. E. & Lenz, M. Colloidal Properties of Nanoparticulate Biogenic Selenium Govern Environmental Fate and Bioremediation Effectiveness. *Environ. Sci. Technol.* 47, 2401–2407 (2013).
2. Lenz, M., Kolvenbach, B., Gyax, B., Moes, S. & Corvini, P. F. X. Shedding light on selenium biomineralization: proteins associated with bionanominerals. *Appl. Environ. Microbiol.* (2011).